

INSIDE JEB

Returning chum salmon shift metabolism to cope with different river temperatures



From the rivers of the Pacific Northwest to those of Russia and Japan, tenacious adult chum salmon converge on their spawning grounds in autumn and early winter to reinitiate the cycle of life. However, Takaaki Abe from The University of Tokyo, Japan, explains that the odysseys endured by the returning fish are not always equal. Fish returning at the beginning of the spawning season will encounter water temperatures around 20°C, while those returning late in the season often endure temperatures that are 10°C lower. This can make a huge difference to cold-blooded (ectothermic) animals, such as fish, which depend on the environment for their body temperature and metabolic performance. Wondering how the fish adapt to the challenges of migrating at different temperatures, Abe and his colleagues Takashi Kitagawa, Yuya Makiguchi and Katsufumi Sato decided to find out how fish returning to two rivers on the Sanriku coast of northern Japan at different stages of the spawning season cope.

Local fishermen helped the scientists by catching the returning salmon as the

animals fought their way up the Kitakami River in October and the Kasshi River in December and January. ‘We often went to the river, maybe 100 days in total’, recalls Abe. Then, the pressure was on to measure the metabolic rates of the animals as the team knew that the returning fish only had 1–2 weeks to live.

Keeping small groups of early-returning Kitakami salmon at temperatures ranging from 12 to 24°C, while the later-returning Kasshi fish were kept in slightly cooler water from 8 to 22°C, the team measured the fish’s oxygen consumption when swimming very slowly and when swimming their hardest against a fast-flowing stream. Then, they transferred the fish to a tank where they could gradually increase the temperature until the animal toppled over, in order to find the highest temperature that the fish could bear, before cooling the water rapidly and allowing them to recover from their hot flush.

Calculating the fish’s resting and maximum metabolic rates from their oxygen consumption, and then subtracting the resting metabolic rate from

the maximum – to determine their full metabolic range (known as the aerobic scope) – it was clear that the fish from the two rivers had similar aerobic scopes. However, the fish that returned the Kitakami River earlier in the spawning season were better prepared for the warmer temperatures. Their aerobic scope peaked at a temperature that was 3°C higher than the aerobic scope of the winter-returning Kasshi River fish.

The team suspects that the Kitakami fish population, which returns early to a warmer river than their late-returning Kasshi River cousins, adjust their metabolism to enable them to swim upstream in the warmer conditions. And they suspect that this adaptability may help the migrating animals to lower their energy costs during their epic life-long odysseys by seeking deep water at the right temperature.

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